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ABSTRACT

Three general features of scholarly journals--internal processing, format, and form--are examined with regard to journals published by the American Institute of Physics (AIP). Reasons for the minor impact of electronic processing on output forms and display formats in physics journals are discussed, including the dependence of such journals on the effective use of analog displays for the basic journal format and the continued economic success of the cheaper print-on-paper form. The present use of electronic methods in scholarly journal publishing at AIP is described for three categories of use: (1) electronic mail for communicating among authors, reviewers, and editors; (2) online editing and composing systems; and (3) computerized storage and distribution systems. The possible impacts of electronic publishing in AIP scholarly journals in the areas of internal processing, display formats, and output forms are analyzed; and specific predictions are made as to which sets of AIP publications will be the first to become available for electronic remote accessing. A matrix organizes the publications into non-scholarly/scholarly and digital display/analog display. (Author/LMM)

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Impact of Electronic Publishing on Scholarly Journals

by

H. William Koch

American Institute of Physics

ABSTRACT

The general features of scholarly journals have been defined during their evolution by three principal physical characteristics - internal processing, format, and form. Internal processings performed by publishers have been largely manual, but are shifting to electronics, as implied by the term electronic publishing. While those shifts are becoming complete for some publishers, the impacts on the characteristics of format and form have been minor in the field of physics. One of the reasons is the dependence of physics journals on the effective use of analog displays for the basic journal format. The second reason is the continued economic success of the print-on-paper form that is to be contrasted with the more costly computer-screen form. This report examines the three journal characteristics for journals published by the American Institute of Physics and predicts the very slow drift towards electronic journals.

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INTRODUCTION

Scholarly journals were first established in the mid 1600's by the Royal Society in England. (See Slide 1) Therefore, their characteristics for use in scholarship were well-developed when scientific disciplines began in the United States in the late 1800's. Scholarly journals, such as the Physical Review, that started in 1894, and the Journal of the American Chemical Society, that started in 1879, are still accepted today by members of the physics and chemistry communities respectively in the U.S. as their principal vehicles for scholarship.

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The key ingredient for the success of such journals has been the high quality of the editing and peer reviewing provided by scientific society managements serving as publishers. The roles of the publishers working at the direction of both authors and users in a given scientific discipline have been to: (a) acquire individual manuscripts for journal articles; (b) arrange for editing and peer-reviewing; (c) type-set individual journal articles; (d) periodically produce collections of journal articles in bound sets; and (e) distribute the journals to users. As far as scholars are concerned, journals (a) record information; (b) disseminate information; and, (c) convey honor and recognition on authors. Many of the roles of publishers have been performed manually. Most of the functions and characteristics of scholarly journals have remained unchanged since their beginnings.

The purpose of this talk is to examine the impact of publishing by electronic means on scholarly journals. In order to accomplish this, I will discuss in some detail: first, the characteristics of scholarly journals in physics; second, the status of electronic publishing at the American Institute of Physics; and third, the impact of the latter on the former.

SCHOLARLY JOURNALS IN PHYSICS

Let us begin by reference to three important sets of physical characteristics of Scholarly Journals. As shown in the left hand column of Slide 2, they are "internal processing," "display formats," and "output forms."

Under the heading of internal processing of journals, above the double line, I have listed the two important contributors — copy editors and computers. As will be seen through discussion, the shift in AIP's operation is increasingly to computers; i.e., internally, we are becoming as "electronic" as possible.

However, what happens internally does not mean that the external characteristics, below the double line, such as the display formats or the output forms of journals, must also be "electronic."

In order to explain the meaning and role of the two alternative display formats -- analog or digital — and the two alternative output forms, I have listed an analogy of journals to watches in the right column of this slide. What is happening in the watch industry will be an indicator of what has been happening and will happen with scholarly journals. In both cases, the result is determined by needs and subtle choices of users.

The users of Scholarly Journals in physics are assumed to be physicist scholars who are themselves creators and discoverers of basic simplifications and seminal representations of observations and phenomena in our physical universe. Physicists have somewhat different needs for scholarly journals than do chemists, biologists, and engineers, for example. The latter three often acquire, and want to publish, much larger quantities of numerical data in their scholarly endeavors.

The users of watches, on the other hand, are the general public who have been demonstrating their needs and choices by purchases of two alternative watch formats: analog-display or digital-display. As related in a recent Wall Street Journal article:

> ..."For more than 3,000 years people reckoned the passing of the day by analogies — a shadow creeping across the ground, grains of sand slipping through a pinched vial, mechanically driven pointers rotating on a numbered face."
>
> "Today analog timepieces, as they are called, have lost their dominance. Electronic digits generated by tiny silicon chips and liquid crystal diodes are sweeping away the old faces and hands. Roughly half the 50 million watches and clocks sold in this country last year were digital, up from roughly none a decade ago."
>
> "But does this mean digital is better than analog? Not always, say many industrial psychologists, who specialize in human factors."
>
> "The first impulse was to put digital devices into everything. But they have some serious shortcomings in many applications, and now designers are having to think carefully about what's appropriate..... That means thinking about the specific task the person using the device is going to do — what steps he will take and in what order, and what information he needs..... If he needs precision, maybe the answer is digital. Digital displays present precise quantities very well.... But maybe the user doesn't need that kind of precision. Maybe he just needs to know if something is hot or cold. Maybe he just needs to know that a value is changing but not exactly what that value is." This concludes the excerpts from the Wall Street Journal story.

I was fascinated by that story because it helped explain why I find it essential to have a digital watch for use in my daily jog and why my wife finds it equally essential to wear an analog watch to explain to grandchildren what "one-quarter past the hour" means. Both choices are equally appropriate for the uses intended. The story, also, caused me to look at other examples, such as the sketch of a check in the next slide (See Slide 3) on which numerical information is presented in both analog-display and digital-display formats. In contrast to the watch, the check illustrates that, for most uses, the digital-display format is much to be preferred. Can you imagine balancing a checkbook if you were forced to use only the analog displays on your checks?

Now that we have established that internal processing for journals and watches should be separate in our thinking from the external characteristics such as the display formats; and now that we have made clear the meaning of a display format, let us apply, more specifically, the comments about analog-displays and digital-displays to journals published by the American Institute of Physics, and, to the needs of physicists for those journals (See Slide 4). An example of an AIP journal that is primarily an analog-display journal is the Journal of Applied Physics.

Examination of pages in the Journal of Applied Physics will show you that the components of the pages are photographs, diagrams, equations and coordinated sets of words. (See Slide 5) All of these components are analogs. Photographs depict the real life object being photographed; diagrams can be a representation of a trend of a physical quantity measure; equations can be a mathematical analog of an observable phenomena; and coordinated sets of words stand for objects, phenomena, and processes intended to be represented by words written by the author of the words. (See Slide 6).

Indeed, a photograph, a diagram, an equation, or a given set of words can be interpreted quite differently by a human reader depending upon the intellectual characteristics of that reader. Also, typographical errors and misspellings can be tolerated in the publication of analogs without confusing the reader about the author's intent. For these reasons, peer reviewing serves a very important role in analog-display journals.

This explanation of the nature of analog-display journals can be supplemented with an explanation of the psychological success of such a journal to the reader. I believe there are at least two bases for this success.

First, there is the fact that such analog displays on the page of a journal are good impedance matches to the brain. Remember that the two principal information inputs to the brain are the eyes and the ears, both of which supply information in analog form.

Second, and perhaps of equal importance, is that the parallel display of equations, photos, diagrams, and text on a page is like the parallel processing of information in an analog computer. As described in "The McGraw Hill Computer Handbook", in a comparison of analog to digital computers, "The high speed of the analog computer is the result of its highly parallel operation, i.e. all its parts are working concurrently on the separate parts of the same problem." Back to the case of our analog display journals, this may explain why page lay-out is important in an analog-display journal. The lay-out facilitates the parallel processing of the analog information on a page by the brain of the reader.

Now contrast these journals with digital-display journals. (See Slide 7) One striking way is to decompose a photograph that is clearly an analog display into its component computer bits to produce a digital display. The Xerox Corporation has provided me with the decomposition of a portion of a photograph of an AIP keyboarder by a process called bit mapping. The following slide (See Slide 8) shows the original with a small portion around the ring on the right hand being magnified by 50 times to fill the screen. The results are the raw numbers of computer bits (the "bit map") in Slide 9 that provide the 256 shades of grey which make up the small portion of the photograph. Would you not agree that the analog information in the original photograph is much more informative and useful than the digital information contained in this matrix of numbers.

My example of bit mapping demonstrates the experience every physicist has had in wanting to plot any table of numbers to obtain an analog representation before wanting to comment on the significance of the numbers. There is no better way to appreciate where there is a minimum or a resonance that is calling for interpretation.

Tables of numbers, such as in a numerical data table of physical constants or in a telephone directory, are the principal components of digital-display journals Examples of digital-display journals are the Journal of Physical and Chemical Reference Data and an AIP Directory of addresses and telephone numbers (See Slides 10 and 11). Each digit is essential. The numbers have a precision determined by the number of significant digits. The authors meant precisely what they wanted the reader to understand when they included a number such as 137 in their journal articles. And typographical errors are intolerable in a digital-display journal.

Digital-display journals lend themselves to inquiry in an on-line form because a single number look-up out of a large set of numbers is ideal for an on-line display. It is clear that these journals in an on-line form may eventually replace the conventional print-on-paper form.

On the other hand, journals with analog-display formats such as the Journal of Applied Physics will now have two alternative forms as a result of the increasingly electronic internal processing of journals. (See Slide 12) The first is an analog display on a computer-monitor screen. This form is poor compared to the second alternative, the more conventional print-on-paper form, because present day television or computer-terminal monitors do not have sufficient spatial resolution to display a full page of the Journal of Applied Physics and still be able to resolve the small (4 point) subscripts and superscripts. It is poor by comparison, also, because only a portion of a page can be read at a time on the monitor and the pages must be read consecutively. Thus the television form does not lend itself to speed reading, extended reading, carrying on a train, or other uses that we associate with print-on-paper form, a form that has been human engineered to great perfection over centuries of experience.

Due to these factors and others, I predict that the present print-on-paper journal publishing program of the American Institute of Physics will continue to expand for the immediate future from the present annual production of 35 journals and 120,000 pages. It will continue because it is supplying what scholars in physics need and are expected to continue to demand. How expansion will continue in the up-coming years may be suggested by my next discussion of "Electronic Publishing at the American Institute of Physics."

ELECTRONIC PUBLISHING OF SCHOLARLY JOURNALS AT AIP

Let us examine the present use of electronic methods in scholarly journal publishing at AIP. These uses can be categorized in three parts. (See Slide 13)

A. Electronic Mail for Communicating among Authors, Reviewers, and Editors.

B. On-Line Editing and Composing Systems.

C. Computerized Storage and Distribution Systems.

A great deal of effort during the last 12 years has been devoted to establishing our on-line editing and composing systems (Category B). Increased attention is now being directed towards developing electronic mail procedures (Category A). The final set of systems for storage and distribution (Category C) are still about three to six years from being economical and otherwise practical. Let's discuss electronic mail first.

A. Electronic Mail

Conventional systems of transmitting abstracts and manuscripts via the U.S. mail are slow and increasingly unreliable. One need only look at the tremendous popularity of Express Mail to see that conventional mail is inadequate. More specifically, AIP knows from experience with tens of thousands of abstracts and manuscripts per year that delays in transit and lost manuscripts are real problems. So it is urgent that we modernize our scholarly journal input. The modernization will start in the following three areas:

1. Electronic Mail for Abstracts

2. Electronic Mail for Compuscripts

3. Electronic Mail for Editors

1. Electronic Mail for Abstracts

Communicating abstracts in computer readable form is the first stage to communicating the full-texts of manuscripts in computer readable form that, incidentally, are called compuscripts. Let us discuss first the abstracts and then compuscripts.

Abstracts at AIP appear typically in the bulletins of abstracts of talks to be presented at physics society meetings. In the case of many societies, these abstracts are presently transmitted by authors typed on a sheet of paper ready to be photographed.

In the future, we envision that abstracts from personal computers, computer terminals, and word processors would be transmitted to AIP's electronic mail box on a network, such as Source, Compuserve, Scinet, or other. The abstracts are typically 200 words or 1200 characters long. Therefore, on a conventional telephone line with transmission speeds of 1200 baud or 120 characters per second, the abstract would take 10 seconds to be transmitted to AIP's mail box. Receipt of all abstracts on the deadline day should be feasible. Subsequent computer processing would then produce computer-organized sessions of abstracts for review by a committee before release for on-line inquiry and publication in an abstracts bulletin. This procedure speeds up production and helps insure that the abstracts bulletin reaches subscribers before the meeting date. It would also make it possible for physicists around the world to monitor on-line the titles and abstracts of the talks in a subject area of interest being presented anywhere, at any time, and in any discipline. An up-coming meeting of an AIP member society has agreed to make experimental use of this new concept.

2. Electronic Mail for Compuscripts

The next stage after abstracts would be to take on the task of communicating compuscripts from authors to editors to reviewers and back to authors for final editing and release. Manuscripts are typically 25 times longer than are abstracts. They are also more complex because of figures, photos, and tables in addition to text. Here again the effort is being handled a step at a time with the communication of full-text having top priority for early attention.

A pre-requisite for communicating full-text is editorial standards. Two parallel efforts are proceeding here. The first is the development of an editorial and typographic style guide for input to the on-line editing and composition system of the American Physical Society. Several manuscripts in computer readable form are presently being processed by this system. These experiences will be useful in establishing practical standards.

Second, book publishers are well advanced in handling the output of word processors for direct input to electronic editing and composing systems. A committee sponsored by the Association of American Publishers is attempting to develop generic standards for electronic versions of book manuscripts. We hope those same standards can be applied to publishing of journals containing large quantities of built-up mathematics. At present, AIP is actively participating on the AAP committee.

3. Electronic Mail for Editors

All scientific editors of AIP-owned scholarly journals are remote from AIP. Therefore, it is imperative that AIP staff develop improved procedures for communicating with our editors and for unburdening them of the mechanical problems of communicating and administering journal operations. One formidable problem that AIP staff has observed in this process is the national experience called "telephone tag." AIP copy editors telephone scientific editors and invariably find that they are not close to the telephone instrument being called. Messages to return the call go back and forth several times before actual contact is made.

Analog systems called phonemail, and digital systems called electronic mail will improve efficiency enormously because they make it possible to leave messages and obtain prompt responses. Electronic mail seems more appropriate for AIP's purpose than electronic conferencing, which is an interactive system that is more demanding of the participants. Phone mail and electronic mail systems are presently being explored at AIP.

B. On-Line Editing and Composition Systems

The critical core of any electronic journal system is the computer hardware and software for accomplishing electronically, the basic functions of on-line editing and photocomposition. Once having developed a reliable, speedy, and economical core operation, it should be possible to receive manuscripts electronically from authors into the core system, then to distribute them initially to reviewers, and finally, to subscribers located remotely in the form of journal articles. This eventual goal is gradually being accomplished at AIP with two separate core systems called ATEX and UNIX. Two systems are being tried and compared because each has its advantages and disadvantages. It was felt unwise to commit to only one system until we had gathered more experience because the total AIP production of composed pages is so large (more than 120,000 journal pages per year). A description of the characteristics and present status of the two systems may be of interest to this audience.

ATEX is a special purpose editing and composition system developed and supported by the ATEX Corporation — a subsidiary of the Eastman Kodak Company. This system is one of the most successful systems now in use for magazine and newspaper publishing. Because it has been especially adapted to handle multi-level mathematical equations successfully, this powerful system is uniquely suited for in-house AIP operations that contain a high proportion of mathematics. The principal hardware feature of ATEX systems is key-boards with many special function keys with direct connection to the computer memory. (Slide 14)

Our experiences with the ATEX system have been twofold: First, the cost of keyboarding a page of mathematical equations is now about the same as the cost of keyboarding a page of straight text. The relative cost experienced with typewriter composition was about three to one. Second, because the ATEX system had been designed to be used for on-line editing and composition, it is proving to be efficient and flexible for just that purpose.

The UNIX system is a general purpose, multi-user, interactive operating system developed by Bell Laboratories. In the form used at AIP for American Physical Society journals, UNIX has two subsystems; one for text processing and composition called TROFF, and the other for setting equations called EQN. The particular features of UNIX are the universality of the basic operating system as a file management system and the standard keyboard. (See Slide 15) Particularly because of these features, UNIX requires more keystrokes than does ATEX to accomplish the same functions. However, the strong points of UNIX are its applicability to general editorial office house-keeping, as well as its compatibility with UNIX operating systems and standard keyboards that are to be found in many physics laboratories around the country. (See Slide 16)

The urgency to undertake the application of computerized composition systems came about because of inflation in labor costs of conventional composition methods. Typewriter composition was costing AIP about $30 per standard journal page of 4000 characters. After one to two years of operation with the ATEX and UNIX systems, our costs are already comparable to what the cost with typewriter composition would have been at this time. Indeed, with our new electronic systems the costs are continuing to come down.

The AIP composition systems are able to handle editorial text, tables, and mathematical equations, but can not yet handle figures, diagrams, and photographs. Equipment called an "electronic digitizer" is available with acceptable spatial resolutions and adaptabilities but is still too costly. When the price of the basic equipmnent comes down by about a factor of two from present day prices, and when the output applications demand digital information, AIP will probably incorporate a digitizer in its on-line editing and composition systems.

The economics are not yet favorable enough to justify production of fully digitized journal pages which can be transmitted via satellite with final laser printers to produce hard copy. Therefore, it would appear that our author-prepared input and composition systems will be years ahead of the output distribution systems. Let me outline our experiences with storage and distribution systems, without going into too many technical details.

C. Computerized Storage and Distribution Systems

A main attraction of optical-disc data storage equipment is its ability to compete with existing magnetic storage systems. One big drawback to date has been its economics.

Ithiel De Sola Pool has given a good summary of one aspect of the economics in the following statement from Daedalus, Proceedings of the American Academy of Arts and Sciences:

> "At the moment, the most promising storage technology is that of videodisks. An optical disk pack of six disks, with a total capacity of a trillion bits, or over one hundred thousand books, may be on the market in 1983 at an estimated cost of $51,000 per pack, the cost of storing a book would be forty cents. One hundred disk packs, or the total contents of the Library of Congress, would cost $5 million and would fit in a medium-size room. Other projections, with different videodisk approaches, are for cost estimates of one cent to a nickel per book. Clearly, the significant costs are not the stored data, but the cost of creating the text, reading it into the medium, and then displaying it when wanted."

De Sola Pool's numbers indicate that the cost of storing one megabit would be four cents. Thus an AIP journal page of 4000 characters or 40,000 bits would cost 0.16 cents. Obviously equipment amortization costs plus "reading it into the medium" costs were not included.

If one calculates a more complete cost for reading and storing a page, the result is more like 60 cents-per-page, as was recently demonstrated in an optical disc storage proposal developed by four European publishers. Essentially, they were proposing to store about 30,000 pages on one disc with 300 lines per inch resolution. This larger figure assumes that no input storage cost is passed on to the eventual customer for a hard copy of a page. I believe this is a reasonable way to assign costs. However, by doing so one demonstrates the prematurity of the current technology. The equipment and development costs are still enormous and the potential customer base is not yet adequately developed. Until the equipment and distribution system has

been developed and paid for, and until the customers are attracted for other economical reasons to the optical disc system, I believe we are a long way from the implementation of such a system with private funds.

Also, optical digital disc proposals presently being developed have as their basic assumption scanning of a printed page which provides the computer bits to be stored on the disc. It may be that we will have to make this process much more efficient by storage of characters from the output of systems such as ATEX and UNIX rather than by the bit-mapping of a page. The use of characters will make "every bit count" and will reduce not only storage costs but communication costs as well.

Until we have reduced these costs, it will be difficult for the new electronic systems to compete with the usual practice of removing journals from shelves and photocopying them. The storage shelves and building space have been paid for long ago, and the labor cost is relatively low.

PROJECTED IMPACTS

This discussion of electronic mail, systems for on-line editing and composing, and other systems for storage and distribution is intended to provide the basis for making some reasonable projections of the possible impacts of electronic publishing on AIP scholarly journals in the areas of internal processing, display formats, and output forms. However, before doing so let me address a point about new and unique opportunities for scholarly journals.

There are, of course, many new external characteristics made possible by the internal processing by electronics in our publishing. However, as you may be aware, AIP has been driven in its choices in the last decade by what makes economic sense. And we have concluded that for the next decade the new external characteristics are:

a. Expensive
b. Require extreme caution
c. Need detailed economic evaluation.

Therefore, let us forget for the remainder of this talk, the new and wondrous electronic opportunities waiting out there within easy grasp and return to practicality by focussing on the possible impacts of electronic publishing on the output formats of analog display and digital display and on the output forms of computer screen and print-on-paper.

Most of the AIP journals are of the analog-display type and only a few are of the digital-display type. I have placed the Journal of Physical and Chemical Reference Data in the latter category. Let us begin by discussing the projected impact of electronic publishing on JPCRD.

In this case, I would agree that this scholarly journal may, for many purposes, be replaced by an electronic journal; i.e., a journal that will be consultable on-line by scientists and engineers by means of a computer terminal. The journal consists almost exclusively of numerical data tables that lend themselves to single-value look-up.

If it were not for the fact that digital-display journals such as JPCRD are the exception and not the rule in physics, one might project the disappearance of the print-on-paper editions for these journals. However, they are the exception; and if analog-display journals are going to require the print-on-paper editions in the future, then the digital-display journals will probably continue to be supplied in that form also. The electronic journals would then be available as a supplement to the conventional form if the electronic form can be made economically viable.

A bigger question will be the projected impact on analog-display journals. In order to address this question, let us reflect for a moment on conventional journals.

These journals are issued periodically as collections of the full-text of primary research articles in a print-on-paper form. Page layout of photos, diagrams, equations, data tables, and text, as well as quality of paper, editing, and location of articles are all important in the decisions by both authors and readers to adopt a scholarly journal as "their" journal and make it a success. Probably more important to success is the fact that the economics of print-on-paper journals are superb and will be hard to beat with any electronic journal in the near future.

Consider those economics. We are delivering, today, articles on a timely basis at a cost of 5 to 10 cents-per-page to a subscriber. Thus, a 10-page article is available for one dollar when it is delivered in bulk together with hundreds of other articles.

Many years will elapse before an electronic version of a scholarly journal article can beat these economics. Consider, for example, that today, single articles that are being produced electronically are being sold by commercial and society information services for 7 to 10-dollars-per-article. This relative cost factor of about ten over the bulk delivery of articles is likely to continue because of at least one important fact. The present bound package of articles is being provided by a well-developed infra-structure of U.S. mails, libraries, and publishers using manual techniques for which most of the capital costs have already been paid. If one goes to electronic versions, the back-files and costs of equipment for storage and delivery, for example, will have to have their investments covered somehow. And those investments, if passed on as costs to the consumer, will drive up the economics of the newer electronic systems.

When one compounds these facts with the relatively small scientific market, particularly in physics, then the features of electronic versions of analog-display journals for instantaneous access in seconds and minutes become, obviously, not worth the cost.

To conclude, I want to give some specific predictions as to which sets of AIP publications will be among the first to become available successfully for remote accessing electronically by users. To do so, I have organized our publications into a two by two matrix, with non-scholarly and scholarly as the headings of the columns, and with digital-display and analog-display as the titles of the rows. The matrix will assist in organizing the four categories in time, as shown in Slide 17.

The timing for publications going "electronic" is as follows: first, (Digital-Non-Scholarly); second, (Digital-Scholarly); third, (Analog-Non-Scholarly); and fourth, (Analog-Scholarly). Therefore, the lower right group which includes almost all of the scholarly journals owned by AIP is expected to take a very long time to go completely electronic. Key influences will be whether every physicist will have ready access to a personal computer; whether searching a full-text data base has important new attractions for scholarly research; and whether the economics of our existing labor intensive library and print-on-paper system become so exorbitant that we will look for other alternatives.

In summary, I conclude that the impact on various physical characteristics of scholarly journals at AIP will be as follows:

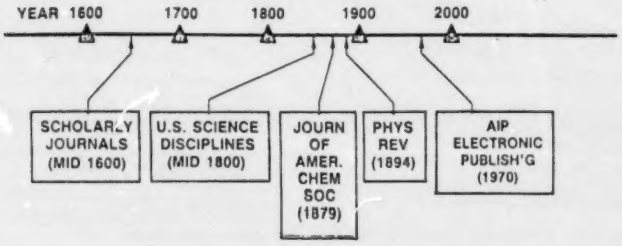
a. Internal Operations - Conversion to electronic methods

b. Digital-Display Journals - Increasingly available on-line

c. Analog-Display Journals - Very little impact during next ten years.

1

EVOLUTION OF SCHOLARLY JOURNALS

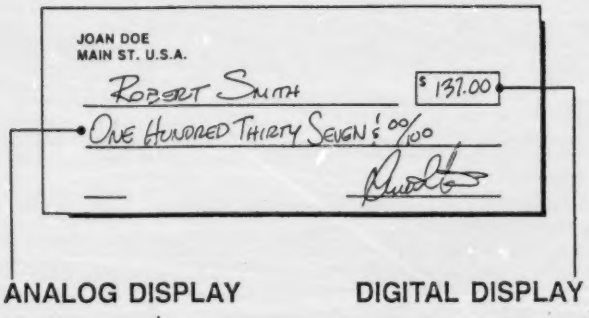


2

	SCHOLARLY JRNLS	WATCHES
INTERNAL PROCESSING	COPY EDITORS COMPUTERS	GEARS MICROELECT.
DISPLAY FORMATS	ANALOG DIGITAL	ANALOG DIGITAL
OUTPUT FORMS	PRINT-ON-PAPER COMPUTER SCRN	WRIST WATCH WALL CLOCK

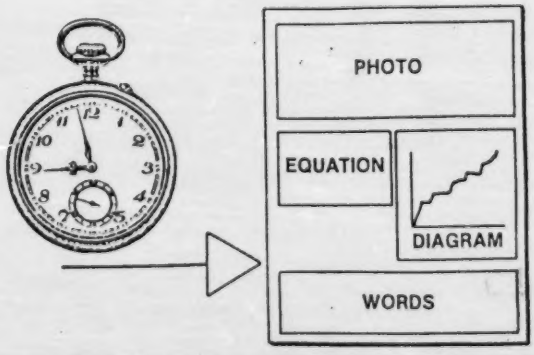
3

ANALOG AND DIGITAL DISPLAYS OF NUMERICAL INFORMATION



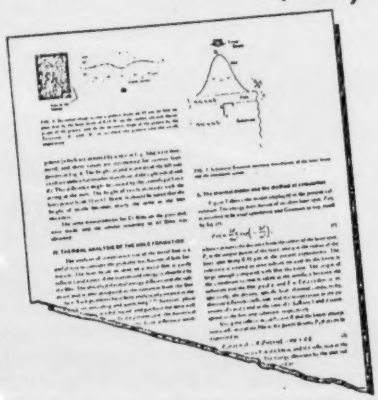
4

ANALOG DISPLAY JOURNAL



5

ANALOG JRNL (JAP)



6

ANALOG DISPLAY FORMATS

ANALOGS: PHOTO - DIAGR EQUAS - TEXT
READER INTERPRETATIONS VARY
TYPO'S TOLERABLE
NEED PEER REVIEW
GOOD IMPEDANCE MATCH USE OF ANALOGS PARALLEL SUPPLY

7

DIGITAL DISPLAY JOURNAL

DIGITAL WATCH

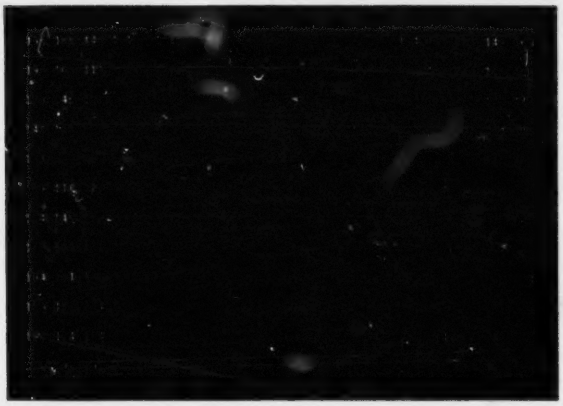
DIGITAL JOURNAL

TABLES OF DIGITS

0000	0100	2000
0100	1100	2100
0200	1200	2200
0300	1300	2300
0400	1400	2400
0500	1500	2500
0600	1600	2600
0700	1700	2700
0800	1800	2800
0900	1900	2900

8

9



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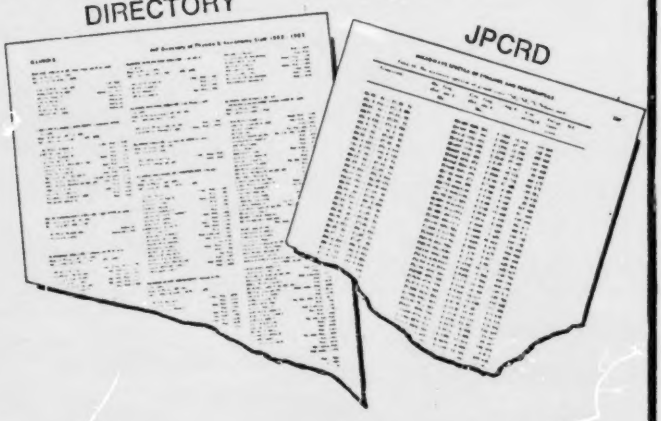
DIGITAL JRNLS

DIRECTORY

JPCRD



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DIGITAL DISPLAY FORMATS

ELEMENTS OF BIT-MAP
INTERPRETATION DIFFICULT
EACH DIGIT ESSENTIAL
TYPO'S NOT TOLERABLE
GOOD FOR ON-LINE FORM

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ALTERNATE FORMS

COMPUTER SCREEN
LACKS RESOL'TN FOR ANALOG GOOD FOR DIGITAL POOR FOR — SPEED READING EXTENDED RDG CARRYING EXPENSIVE

PRINT ON PAPER
WELL HUMAN ENGINEERED ECONOMICAL

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AIP ELECTRONIC PUBLISHING

ELECTRONIC MAIL ABSTRACTS COMPUSCRIPTS EDITORS
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COMPT. STORAGE & DISTRIB.

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